STANDARDIZATION OF POWER SYSTEMS 10-100KW
NUMBER OF COMPONENT PART NUMBERS REDUCED 67%
GROSS PROFIT MARGIN INCREASED BY 17 PERCENTAGE POINTS

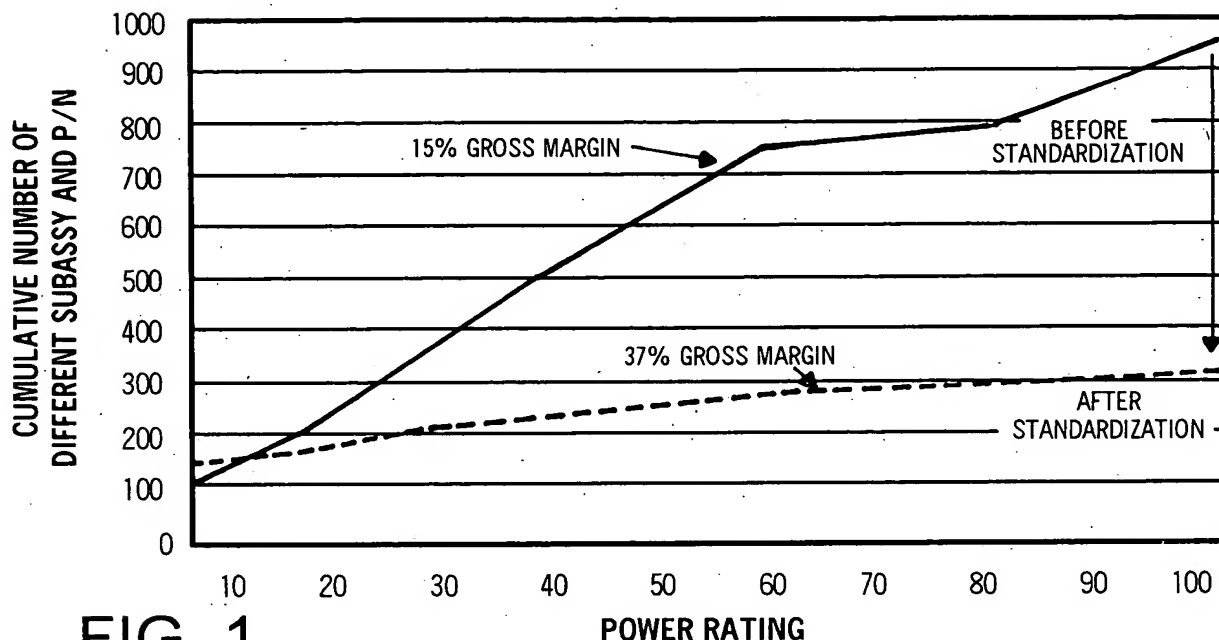
FIG. 1

Economic Profit $ (ROIC-WACC) vs Number of Products
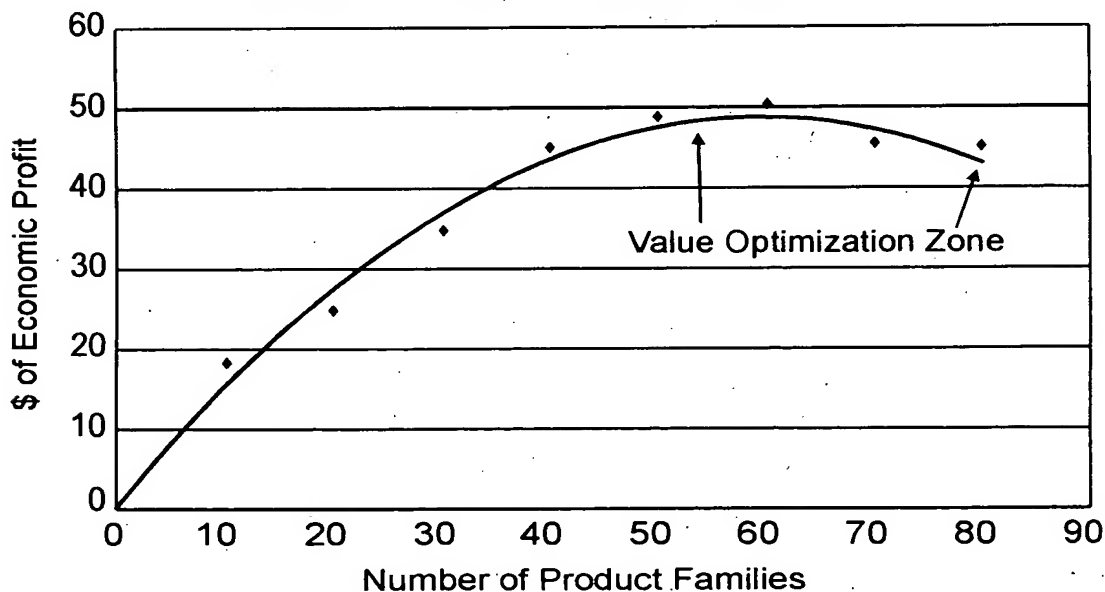Product in Order of Descending ROIC%

FIG. 2

FIG. 3

Reduction of Setup Time or Complexity by 50% or Elimination of 10% Rework
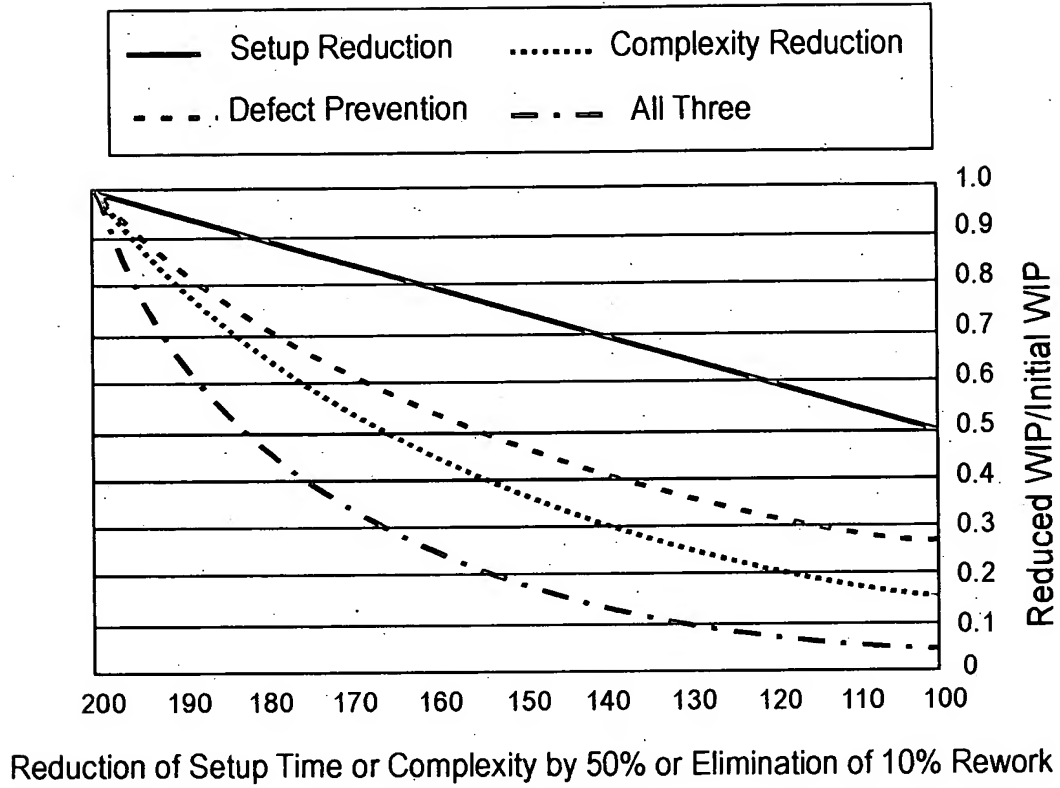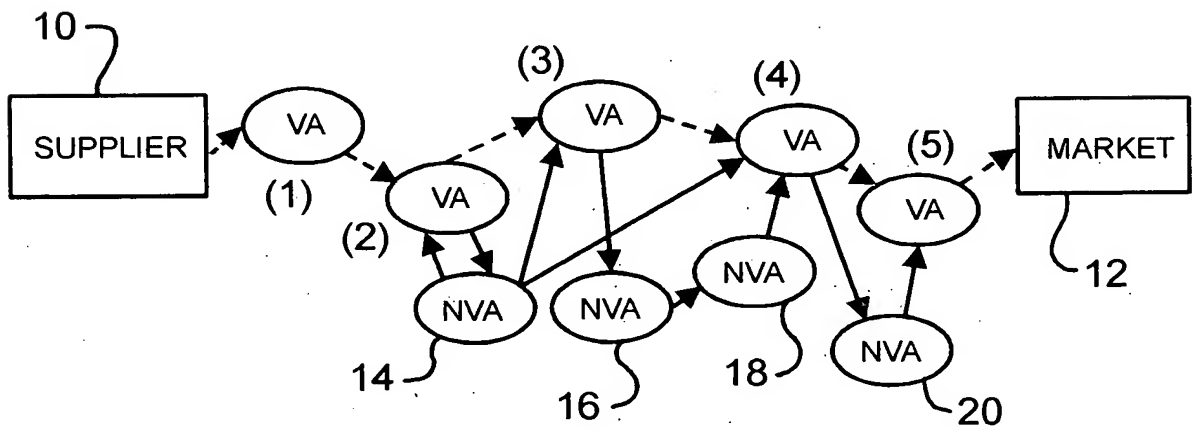
FIG. 4

Cost of Goods Sold % of Revenue vs. Adjusted WIP Turns

Adj WIP Turns = $[(W/W_0)/(COGS_0/COGS)]$

$y = 0.0604Ln(x) + 0.8895$

$R^2 = 0.7316$

COGS % of Revenue

Adj WIP Turns
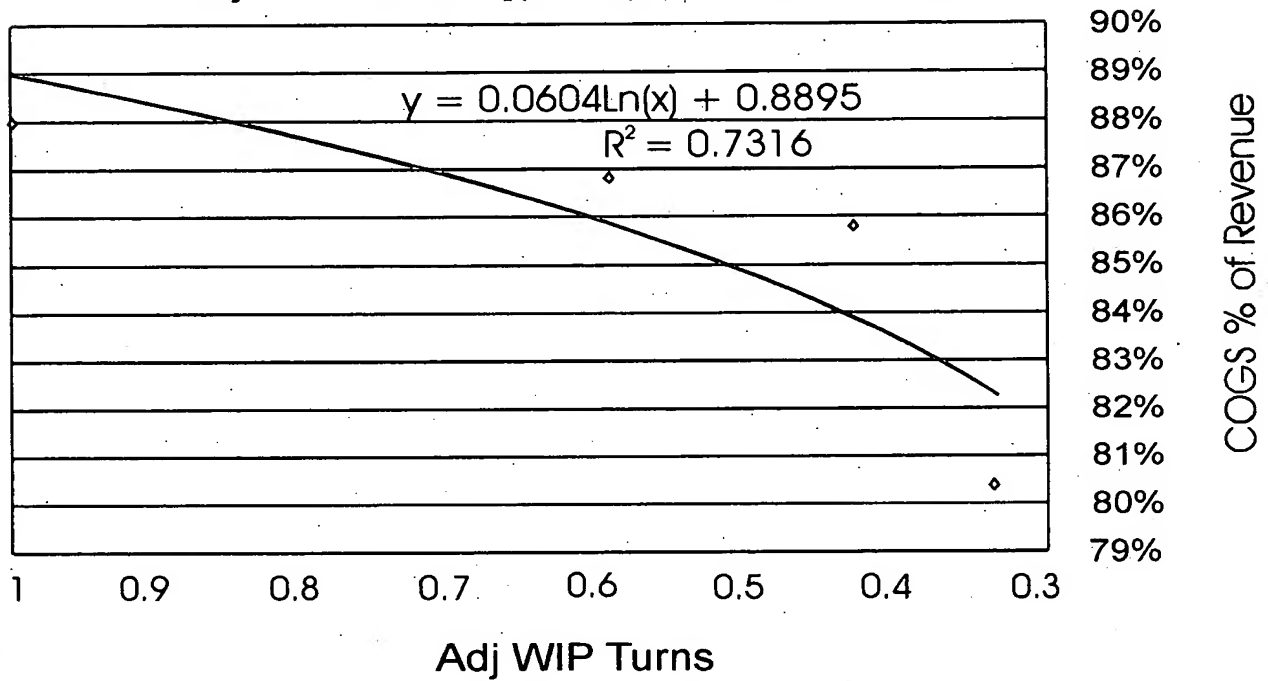
FIG. 5
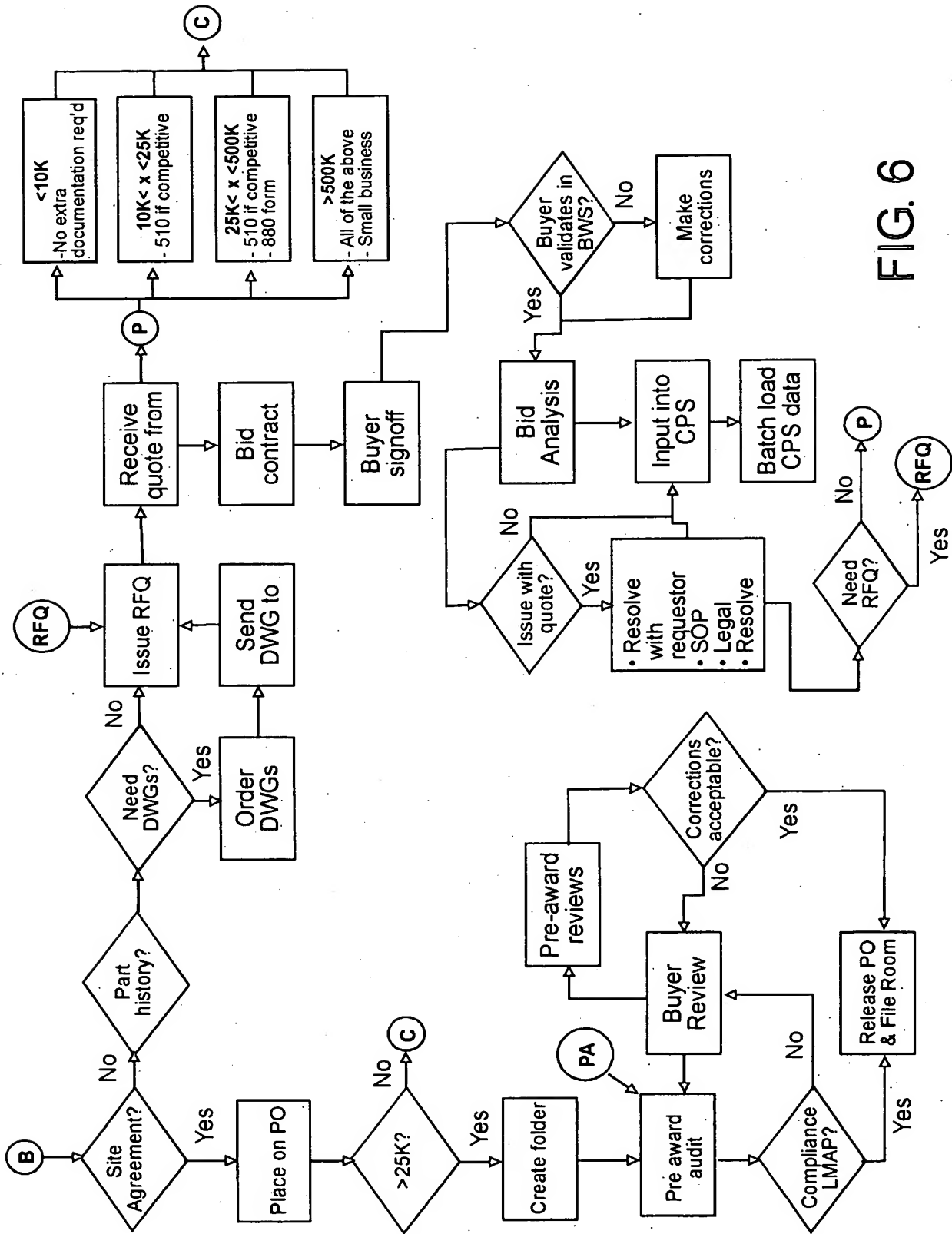
FIG. 6
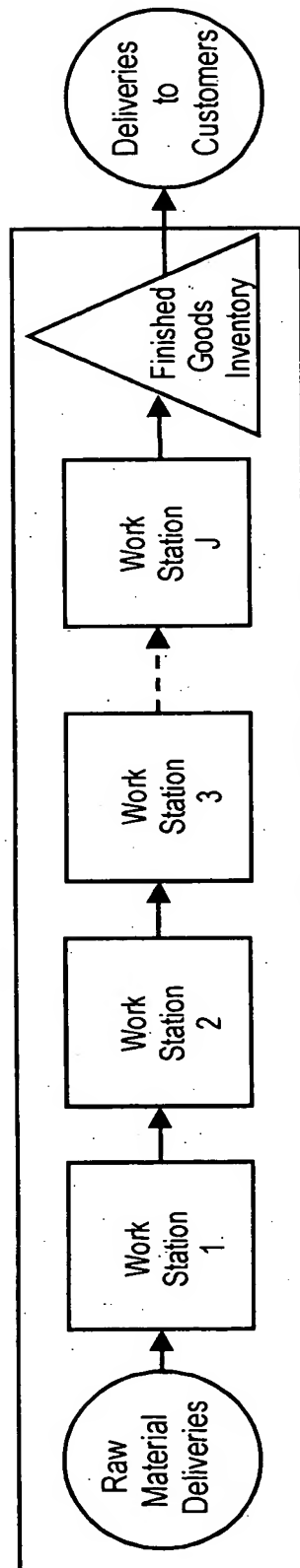
FIG. 7

From	To			WS1	WS2	WS3
0	1			SA	PC	PB
1	2			PA	PC	PB
2	3			PA	PC	SC
3	4	One		PA	SA	PC
4	5	Workstation		SB	PA	PC
5	6	Turnover		PB	PA	PC
6	7	Cycle for		PB	PA	SA
7	8	Station 1		PB	SB	PA
8	9			SC	PB	PA
9	10			PC	PB	PA
10	11			PC	PB	SB
11	12			PC	SC	PB
12	13			SA	PC	PB
13	14			PA	PC	PB
14	15			PA	PC	SC
15	16			PA	SA	PC
16	17			SB	PA	PC
17	18			PB	PA	PC
18	19			PB	PA	SA
19	20			PB	SB	PA
20	21			SC	PB	PA
21	22	One		PC	PB	PA
22	23	Workstation		PC	PB	SB
23	24	Turnover		PC	SC	PB
24	25	Cycle for		SA	PC	PB
25	26	Station 3		PA	PC	PB
26	27			PA	PC	SC
27	28			PA	SA	PC
28	29			SB	PA	PC
29	30			PB	PA	PC
30	31			PB	PA	SA
31	32			PB	SB	PA

Perfectly Synchronized Production Schedule

FIG. 8
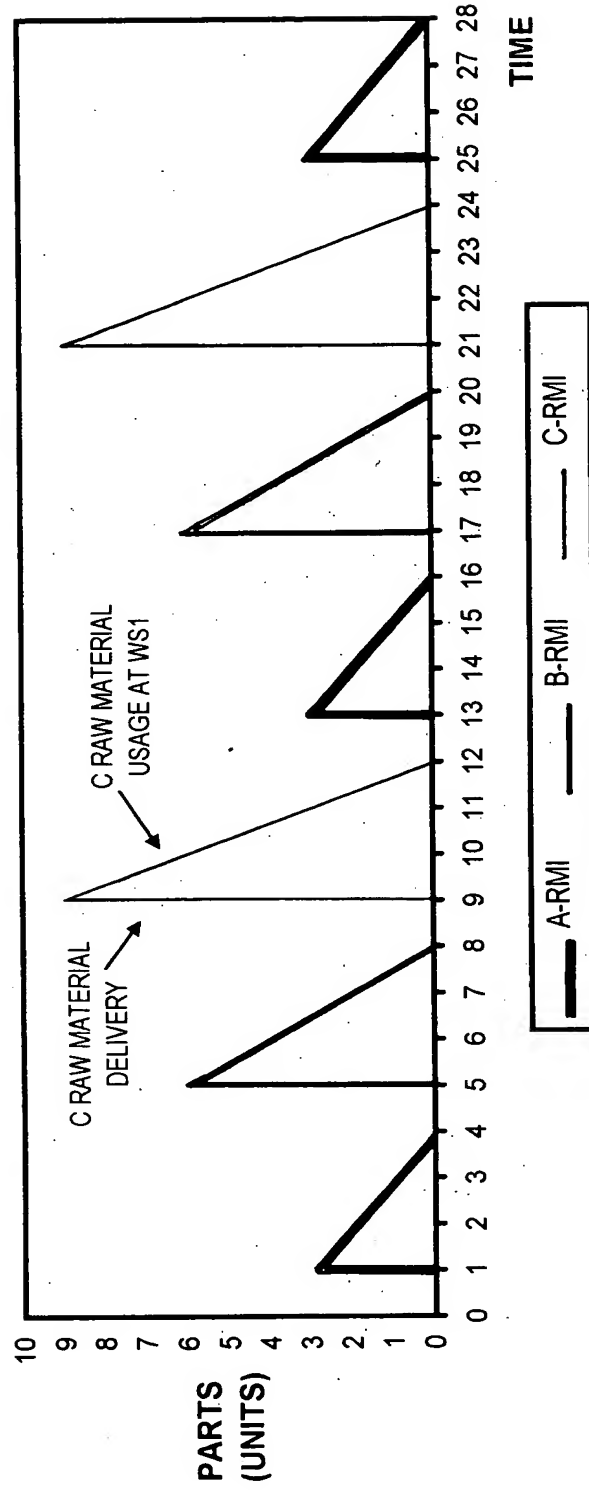
RAW MATERIAL INVENTORY IN FRONT OF THE FIRST STATION, SYNCHRONIZED PRODUCTION

FIG. 9
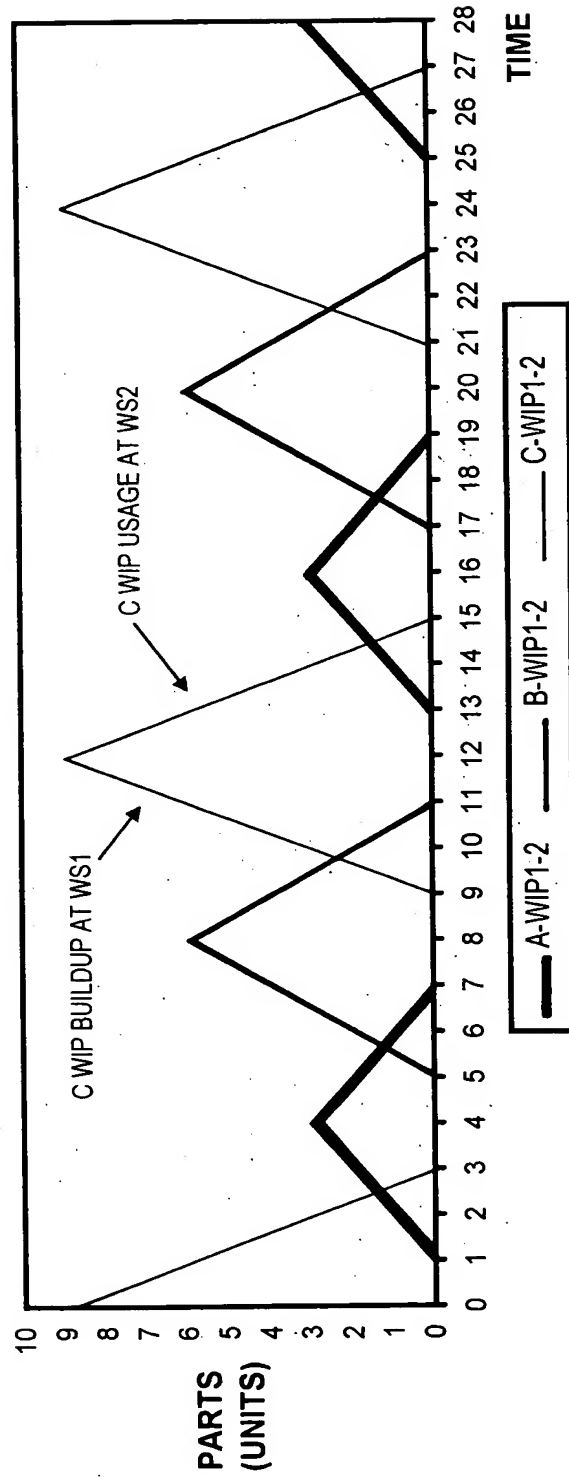
WORK IN PROCESS INVENTORY BETWEEN STATIONS 1 AND 2, SYNCHRONIZED PRODUCTION

FIG. 10

ONE WORKSTATION TURNOVER CYCLE

C FGI USAGE FOR DELIVERY

C WIP BUILDUP AT WSJ

TIME

PARTS (UNITS)

- - A-WIP3-F   — A-FGI   - - B-FGI   —— C-FGI

- - B-WIP3-F   —— C-WIP3-F
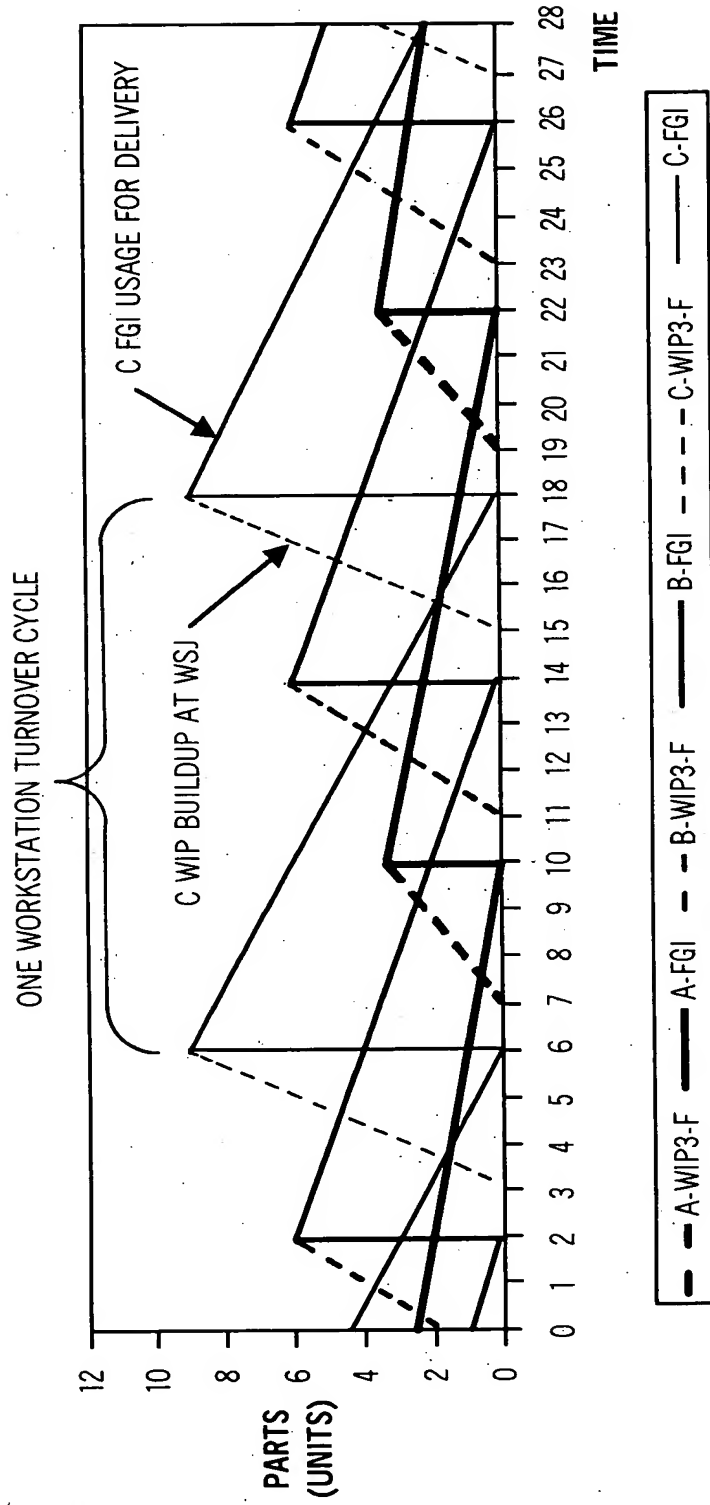
FINISHED GOODS INVENTORY, SYNCHRONIZED PRODUCTION

FIG. 11

AGGREGATE INVENTORY LEVELS, SYNCHRONIZED PRODUCTION

FIG. 12

From	To		WS1	WS2	WS3
0	1		SA	SC	SB
1	2		PA	PC	PB
2	3		PA	PC	PB
3	4	One	PA	PC	PB
4	5	Workstation	SB	SA	SC
5	6	Turnover	PB	PA	PC
6	7	Cycle for	PB	PA	PC
7	8	Station 1	PB	PA	PC
8	9		SC	SB	SA
9	10		PC	PB	PA
10	11		PC	PB	PA
11	12		PC	PB	PA
12	13		SA	SC	SB
13	14		PA	PC	PB
14	15		PA	PC	PB
15	16		PA	PC	PB
16	17		SB	SA	SC
17	18		PB	PA	PC
18	19		PB	PA	PC
19	20		PB	PA	PC
20	21		SC	SB	SA
21	22		PC	PB	PA
22	23		PC	PB	PA
23	24	One	PC	PB	PA
24	25	Workstation	SA	SC	SB
25	26	Turnover	PA	PC	PB
26	27	Cycle for	PA	PC	PB
27	28	Station 3	PA	PC	PB
28	29		SB	SA	SC
29	30		PB	PA	PC
30	31		PB	PA	PC
31	32		PB	PA	PC

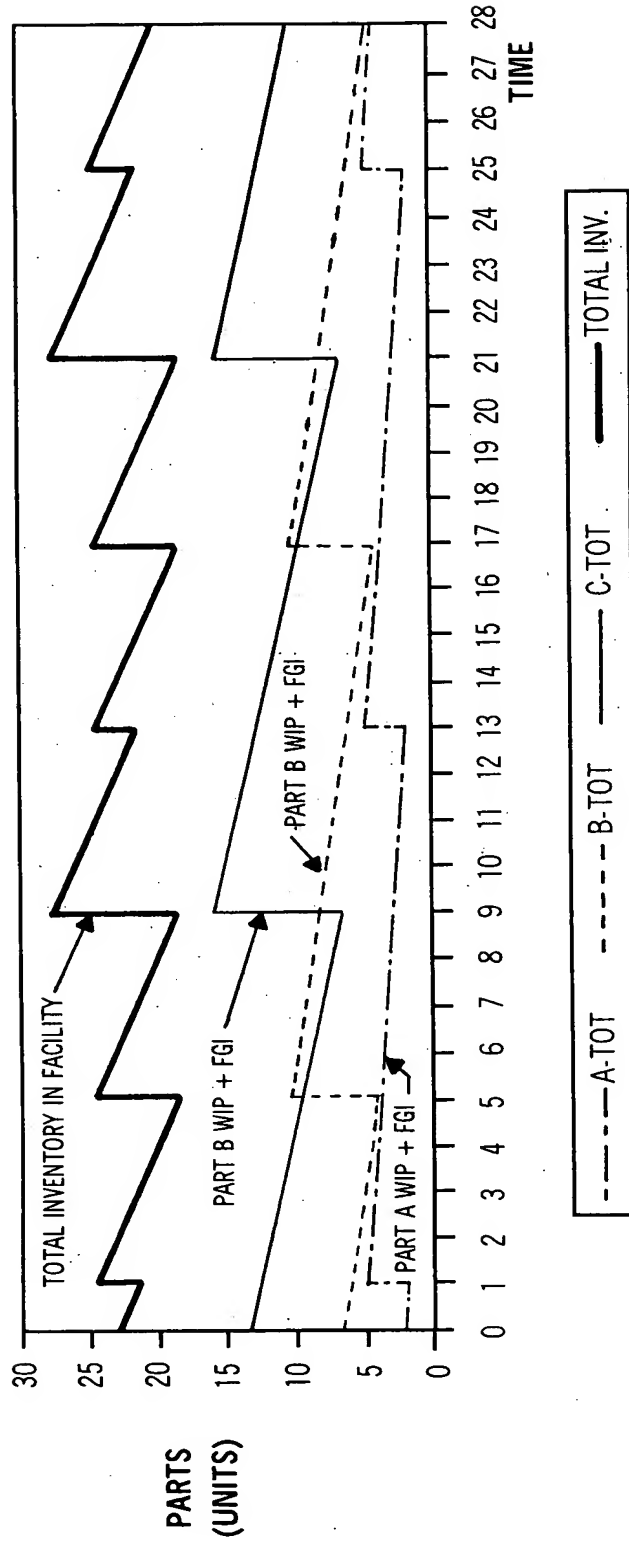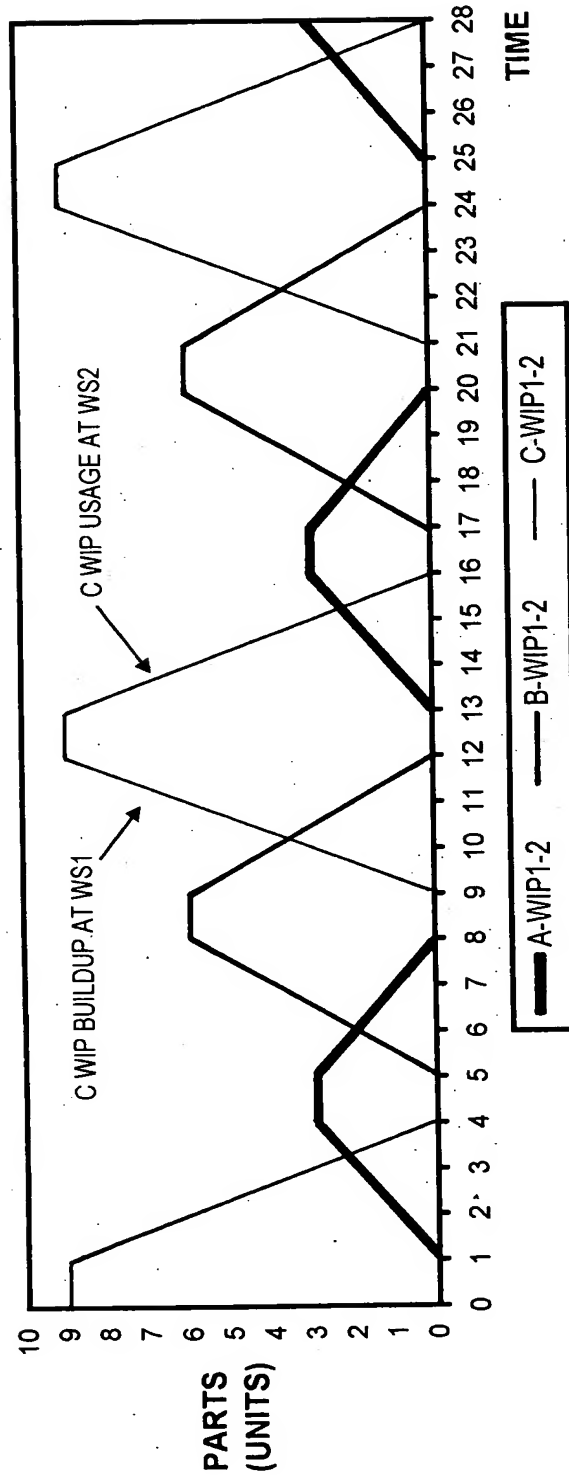Setup-On-Batch-Arrival Production Schedule

FIG. 13
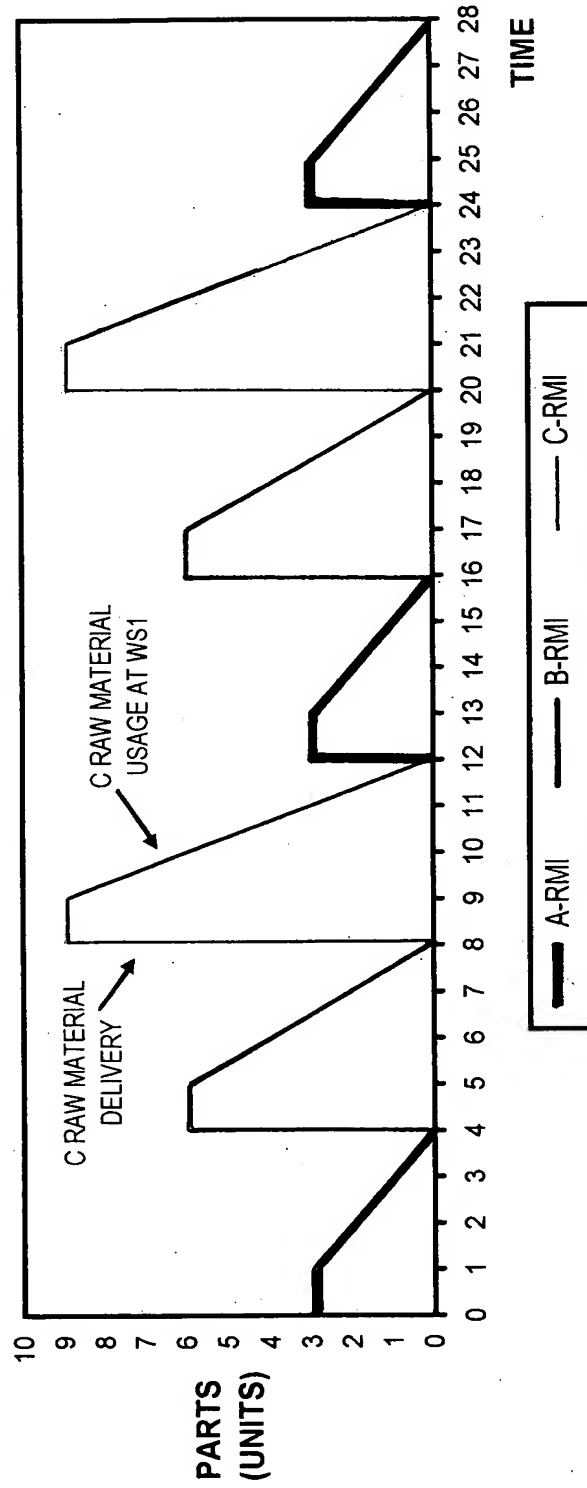
RAW MATERIAL INVENTORY IN FRONT OF THE FIRST STATION, SETUP-ON-BATCH-ARRIVAL SCHEDULE

FIG. 14

C WIP USAGE AT WS2

C WIP BUILDUP AT WS1

PARTS (UNITS)

TIME

A-WIP1-2 ——— B-WIP1-2 ——— C-WIP1-2

WORK IN PROCESS INVENTORY BETWEEN STATIONS 1 AND 2, SETUP-ON-BATCH-ARRIVAL SCHEDULE

FIG. 15
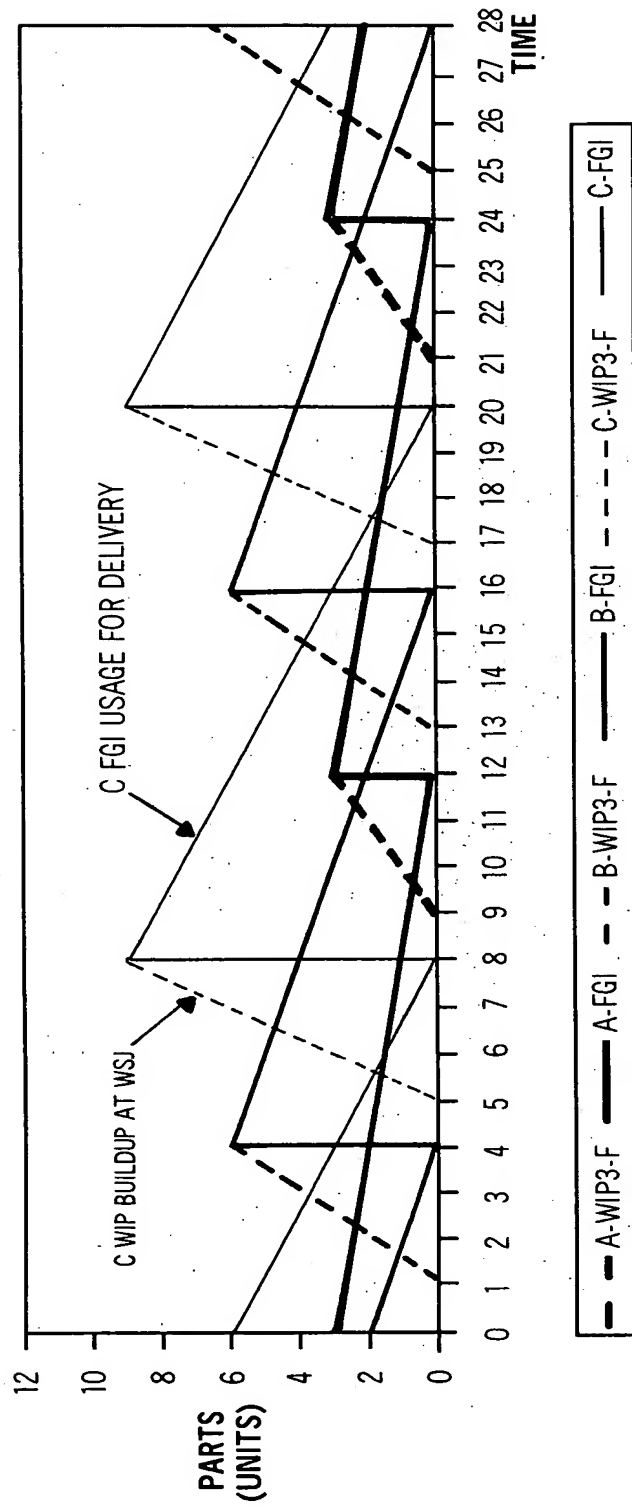
FINISHED GOODS INVENTORY, SETUP-ON-BATCH-ARRIVAL SCHEDULE

FIG. 16
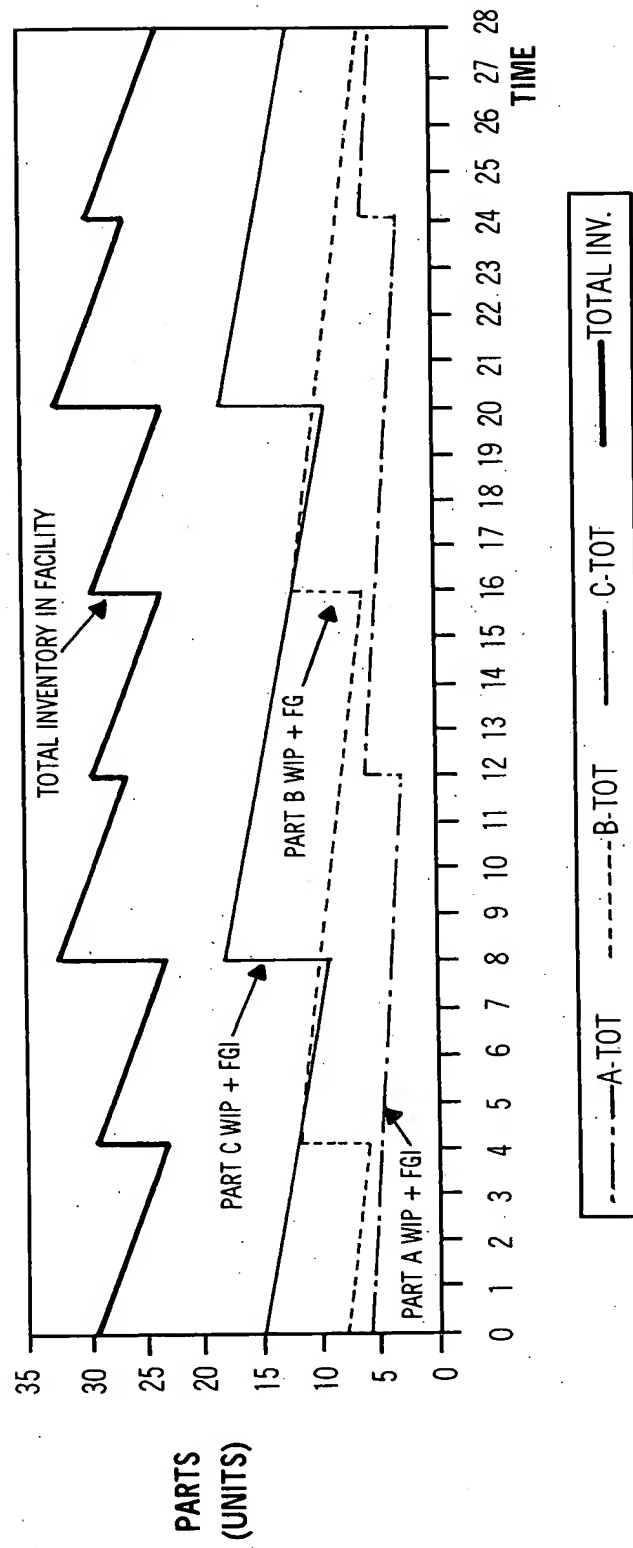
AGGREGATE INVENTORY LEVELS, SETUP-ON-BATCH-ARRIVAL SCHEDULE

FIG. 17

From	To			WS1	WS2	WS3
0	1			SA	SB	SC
1	2			PA	PB	PC
2	3			PA	PB	PC
3	4	One Workstation Turnover Cycle for Station 1		PA	PB	PC
4	5			SB	SC	SA
5	6			PB	PC	PA
6	7			PB	PC	PA
7	8			PB	PC	PA
8	9			SC	SA	SB
9	10			PC	PA	PB
10	11			PC	PA	PB
11	12			PC	PA	PB
12	13			SA	SB	SC
13	14			PA	PB	PC
14	15			PA	PB	PC
15	16			PA	PB	PC
16	17			SB	SC	SA
17	18			PB	PC	PA
18	19			PB	PC	PA
19	20	One Workstation Turnover Cycle for Station 3		PB	PC	PA
20	21			SC	SA	SB
21	22			PC	PA	PB
22	23			PC	PA	PB
23	24			PC	PA	PB
24	25			SA	SB	SC
25	26			PA	PB	PC
26	27			PA	PB	PC
27	28			PA	PB	PC
28	29			SB	SC	SA
29	30			PB	PC	PA
30	31			PB	PC	PA
31	32			PB	PC	PA

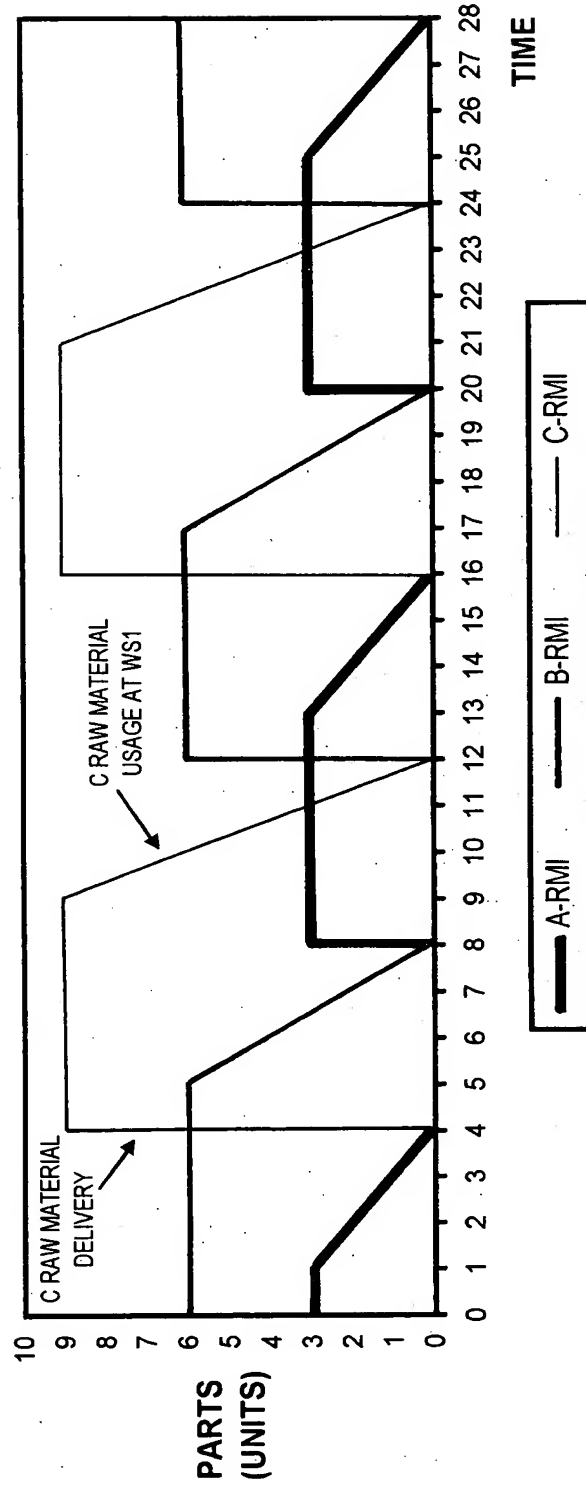Moderately Asynchronized Production Schedule
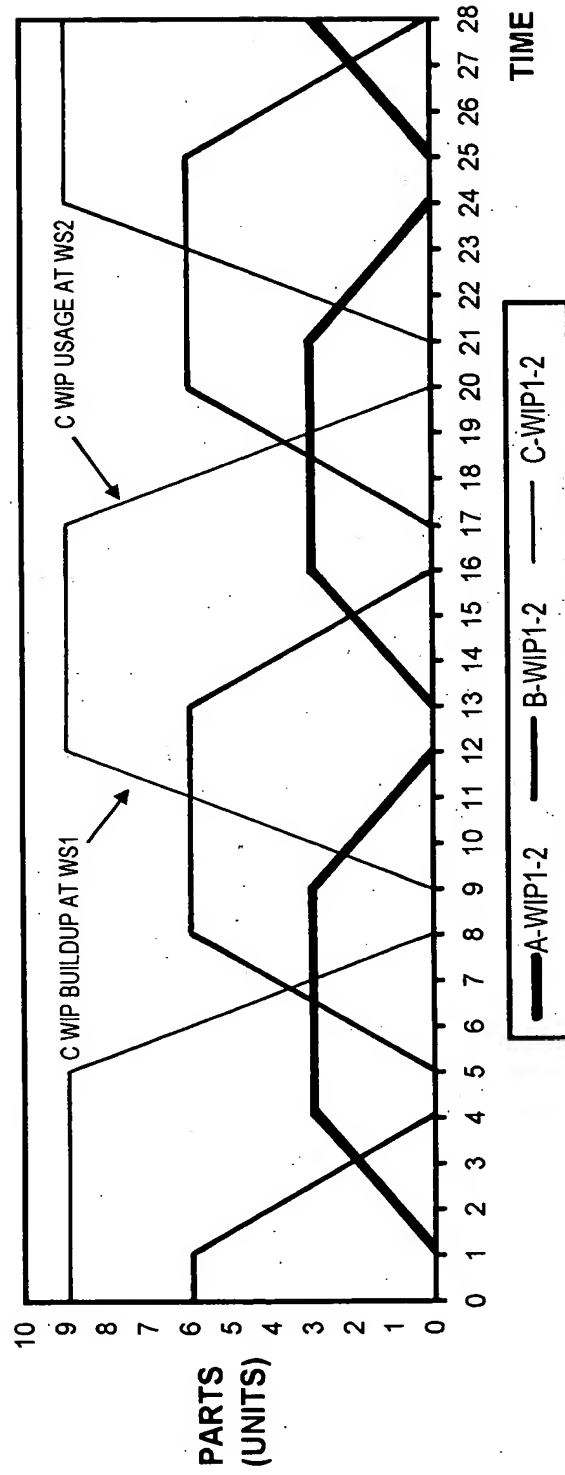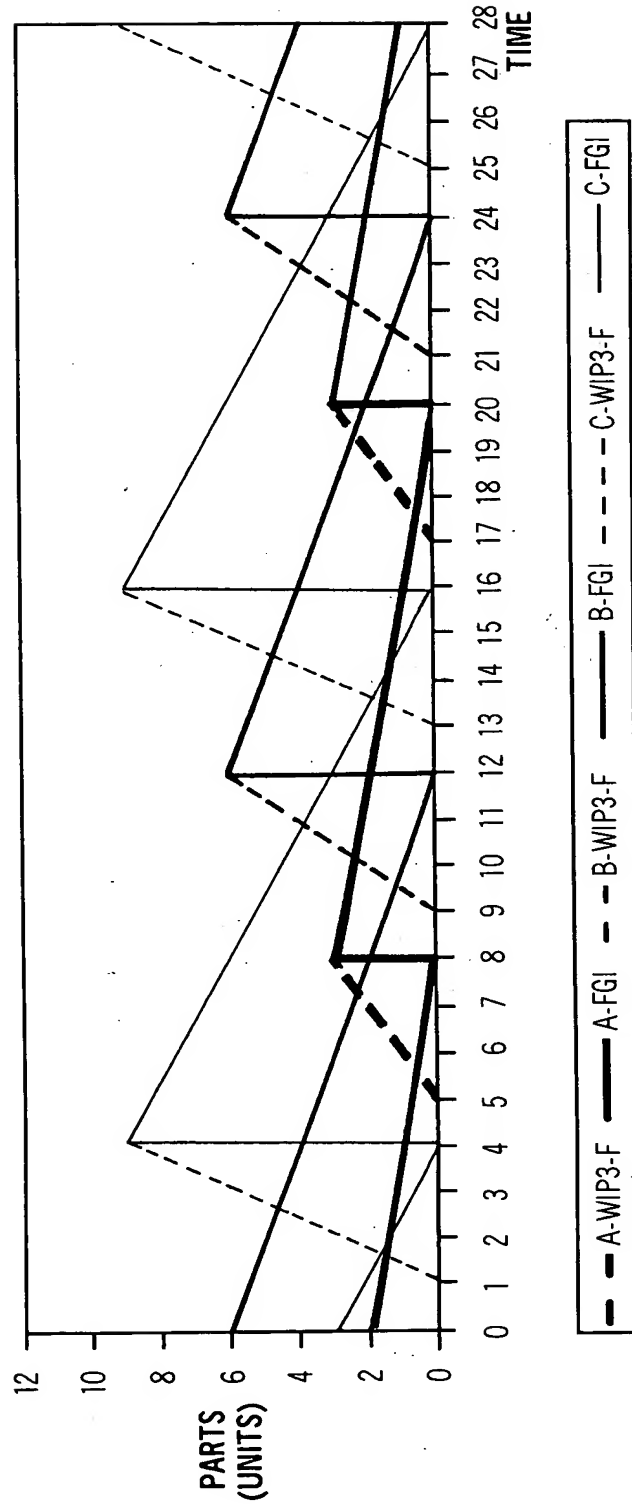
FIG. 18

FIG. 19

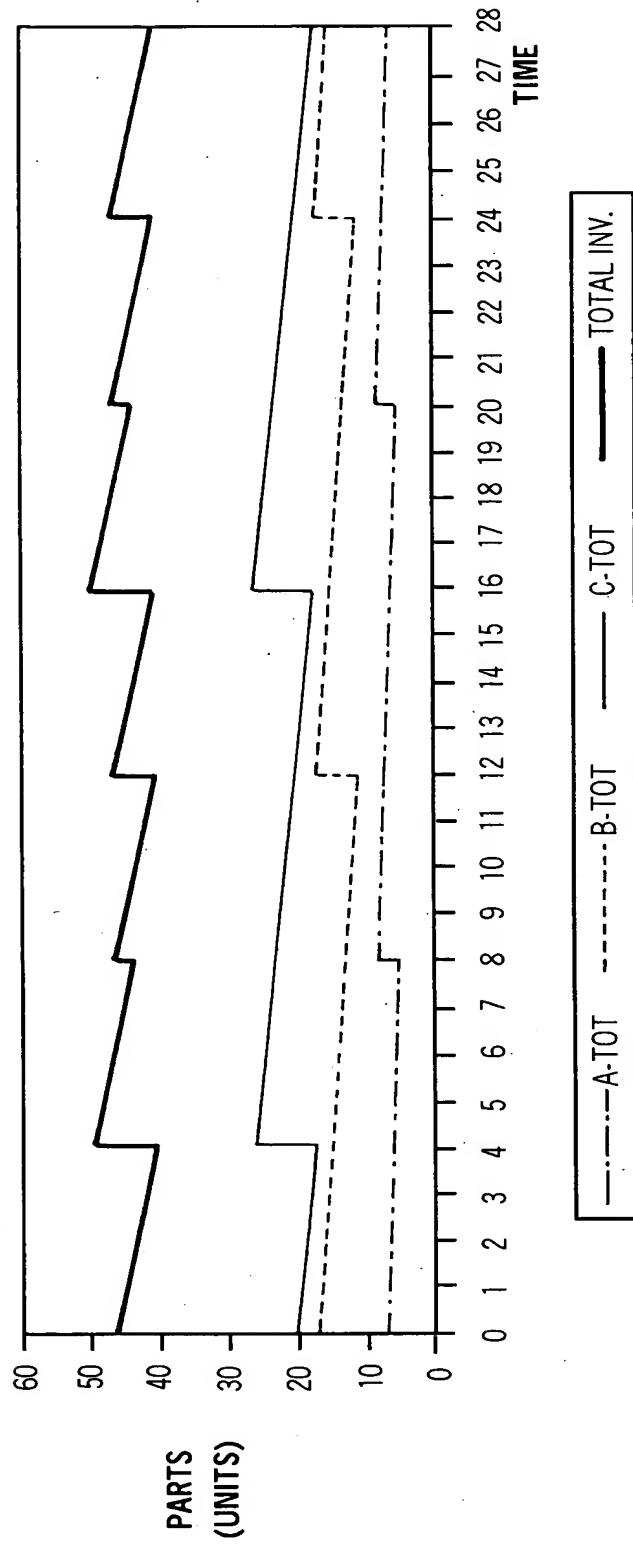RAW MATERIAL INVENTORY IN FRONT OF THE FIRST STATION, MODERATELY ASYNCHRONIZED SCHEDULE

FIG. 20

WORK IN PROCESS INVENTORY BETWEEN STATIONS 1 AND 2, MODERATELY ASYNCHRONIZED SCHEDULE

FINISHED GOODS INVENTORY, MODERATELY ASYNCHRONIZED SCHEDULE

FIG. 21

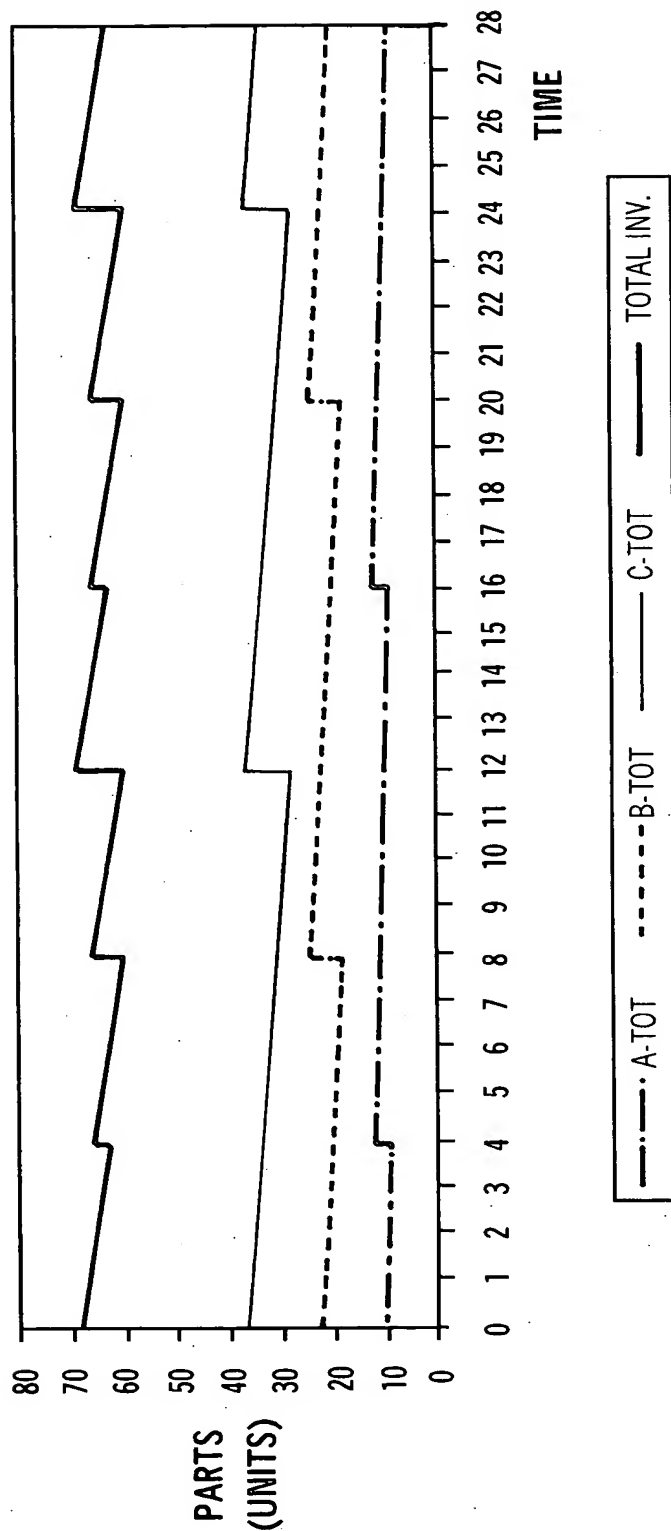AGGREGATE INVENTORY LEVELS, MODERATELY ASYNCHRONIZED SCHEDULE

FIG. 22

From	To		WS1	WS2	WS3
0	1		SA	SA	SA
1	2		PA	PA	PA
2	3		PA	PA	PA
3	4	One	PA	PA	PA
4	5	Workstation	SB	SB	SB
5	6	Turnover	PB	PB	PB
6	7	Cycle for	PB	PB	PB
7	8	all Stations	PB	PB	PB
8	9		SC	SC	SC
9	10		PC	PC	PC
10	11		PC	PC	PC
11	12		PC	PC	PC
12	13		SA	SA	SA
13	14		PA	PA	PA
14	15		PA	PA	PA
15	16		PA	PA	PA
16	17		SB	SB	SB
17	18		PB	PB	PB
18	19		PB	PB	PB
19	20		PB	PB	PB
20	21		SC	SC	SC
21	22		PC	PC	PC
22	23		PC	PC	PC
23	24		PC	PC	PC
24	25		SA	SA	SA
25	26		PA	PA	PA
26	27		PA	PA	PA
27	28		PA	PA	PA
28	29		SB	SB	SB
29	30		PB	PB	PB
30	31		PB	PB	PB
31	32		PB	PB	PB

Fully Asynchronized Production Schedule

FIG. 23

AGGREGATE INVENTORY LEVELS, FULLY ASYNCHRONIZED SCHEDULE

FIG. 24

Schedule Case	Minimum Aggregate Inventory	Maximum Aggregate Inventory
1. Perfectly Synchronized	18.5	27.5
2. Setup-on-Batch-Arrival	23.0	32.0
3. Moderately Asychronized	41.0	50.0
4. Fully Asynchronized	59.0	68.0

Comparison of Aggregate Inventory Levels

FIG. 25

Total Average WIP Calculations

		Number of Fast Movers					
		2	3	4	5	6	7
	0	1000	1500	2000	2500	3000	3500
	1	1164	1695	2220	2741	3259	3776
	2	1341	1903	2452	2994	3530	4062
Number	3	1530	2123	2695	3257	3812	4359
of	4	1731	2352	2950	3531	4102	4666
Slow	5	1945	2595	3215	3818	4405	4983
Movers	6	2171	2849	3491	4112	4716	5309
	7	2410	3114	3779	4417	5038	5646
	8	2659	3391	4078	4734	5370	5990
	9	2922	3680	4387	5062	5712	6346
	10	3200	3980	4710	5400	6065	
	11	3483	4292	5039	5747		
	12	3781	4614	5380			
	13	4092	4948				
	14	4414					

Total Average WIP for the Complex Facility

FIG. 26

Total Average WIP Calculations (cont.)

		Number of Fast Movers							
		8	9	10	11	12	13	14	15
	0	4000	4500	5000	5500	6000	6500	7000	7500
	1	4291	4803	5316	5826	6336	6846	7356	7863
	2	4591	5117	5641	6163	6683	7203	7720	
Number	3	4902	5441	5976	6509	7040	7567		
of	4	5222	5774	6320	6864	7404			
Slow	5	5553	6115	6673	7228				
Movers	6	5891	6467	7035					
	7	6239	6826						
	8	6600							
	9								
	10								
	11								
	12								
	13								
	14								

FIG. 27

FIG. 28

BACKLOG AVERAGE AT 100% UTILIZATION, 3 FAST, 2 SLOW PARTS

$y = 0.1263x + 0.9618$
$R^2 = 0.7915$

$y = 16.846x + 44.707$
$R^2 = 0.8761$

FAST MOVERS
SLOW MOVERS
LINEAR (SLOW MOVERS)
LINEAR (FAST MOVERS)

SLOW MOVER PCS

FAST MOVER PCS

DEMAND COV
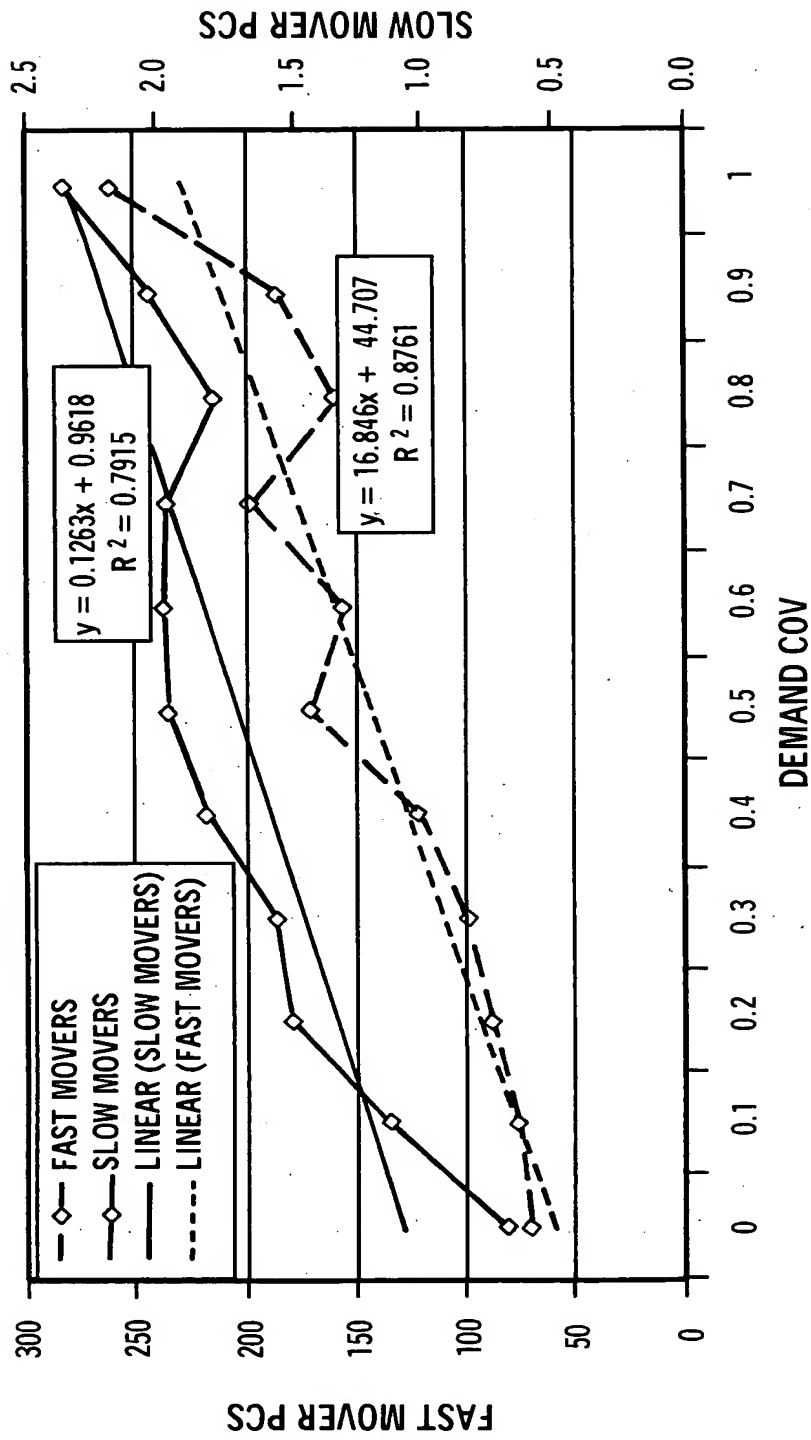
AVERAGE BACKLOG WITH DEMAND VARIATION

FIG. 29

BACKLOG AVERAGE AT 100% UTILIZATION, 3 FAST, 2 SLOW PARTS

$y = 0.3197x + 0.7316$
$R^2 = 0.8875$

$y = 162.02x - 137.77$
$R^2 = 0.8776$

FAST MOVERS
SLOW MOVERS
LINEAR (SLOW MOVERS)
LINEAR (FAST MOVERS)

SLOW MOVER PCS

FAST MOVER PCS
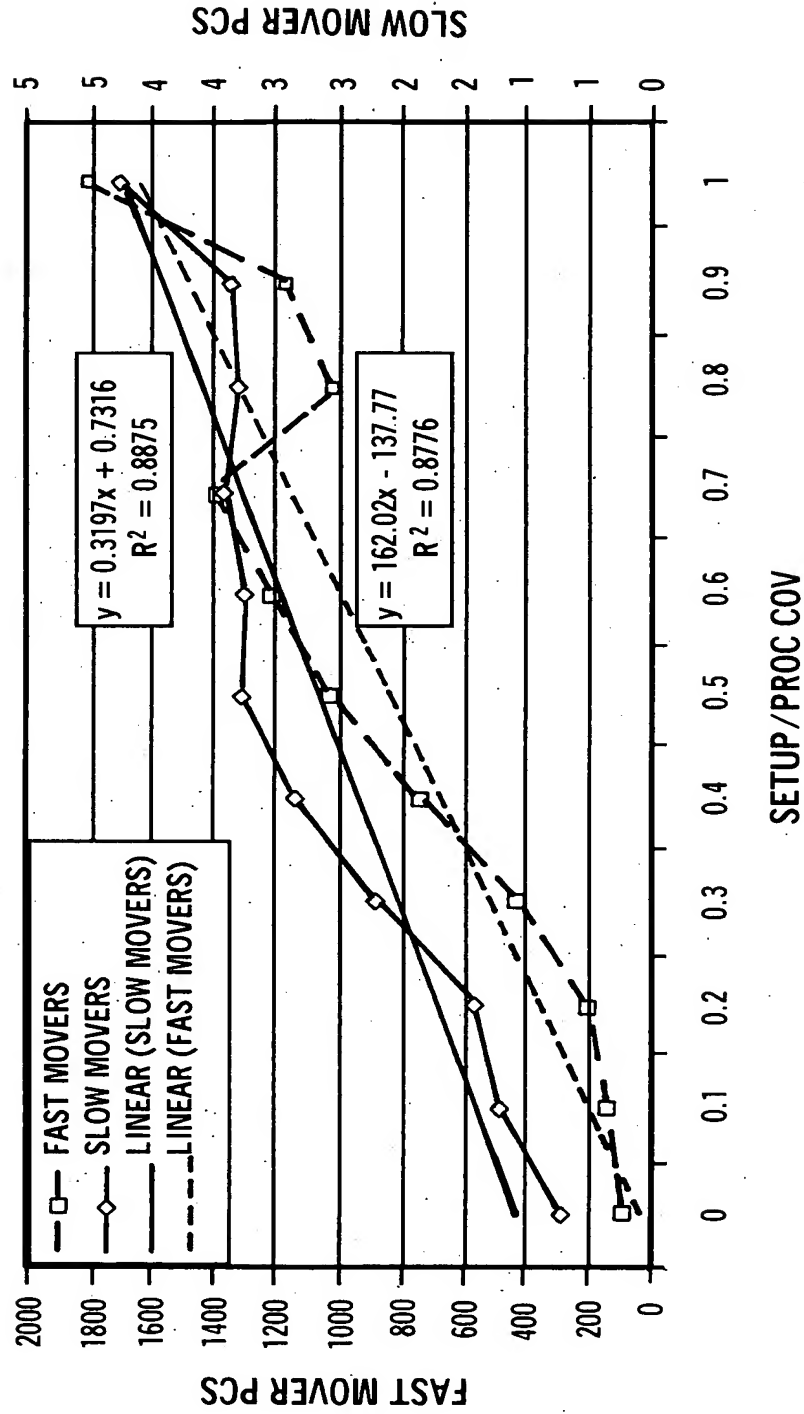
SETUP/PROC COV

AVERAGE BACKLOG WITH SETUP/PROCESSING VARIATION

FIG. 30

FIG. 31